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ABSTRACT

The expanding needs and growing expectations of employers make it very clear that vocational-technical education must give concentrated attention to critical thinking, problem solving, and decision making. The impetus for today's higher-order thinking skills movement can be traced to a number of sources, most of which gained prominence during the first half of the 1980s. There is no single, generally accepted definition of the term "higher-order thinking skills." However, a review of the pertinent literature indicates that this broad term includes the following: critical thinking, creative thinking, problem solving, decision making, and reasoning. Much of the research on information-processing and learning styles complements other research being done in areas related to higher-order thinking skills: intelligence, competence, comprehension, and creativity. Not only must educators understand the general nature of the cognitive process involved in higher-order thinking, but they must also consider the conditions and factors that influence these processes among individual students. By following a series of recommendations, vocational administrators and teachers can transform vocational education into an exemplary teaching and learning laboratory for the development of higher-order thinking skills. (MN)

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TEACHING HIGHER ORDER THINKING SKILLS:

IMPLICATIONS FOR VOCATIONAL-TECHNICAL EDUCATION

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Ohio Council on Vocational Education
1988

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***Mr. Myers resigned from the Council, effective January 4, 1988, when he assumed the position of Assistant Superintendent of Van Wert City Schools.

FOREWORD

What a time to be a student, teacher, school administrator, or member of the governing board of an Ohio school district or postsecondary institution!

The hopes and fears of Americans searching for an effective response to the changing world economy and accelerating global competition have fallen with rare intensity on the schoolhouse and board room.

Concerned Americans know one thing above all else: our best hope as a nation lies in the competence of our human resources.

Knowledge must be acquired.

Skills must be developed.

Attitudes must be refined.

Values must be shaped.

All of this must happen repeatedly in the life of each citizen.

To paraphrase the advertising signature of a major manufacturer: "Education has become 'Job 1' of all Americans."

In the area of skill-development, there is a growing interest in "higher order thinking skills." The Ohio Council on Vocational Education concluded early in 1987 that the time had come to examine this subject, with an eye toward identifying the implications for vocational-technical education in teaching higher order thinking skills.

The Council engaged Dr. Margaret A. Mauter to conduct a study and prepare this report. Dr. Mauter has produced a report that attempts to increase the awareness level of educators about the importance of, and issues related to, teaching higher order thinking skills to vocational-technical students.

A number of educators already are actively committed to improving the thinking skills of their students. However, for those who have yet to become involved, this report should help steer them toward a deeper and more serious commitment to incorporating the teaching of higher order thinking skills in their curricula.

Higher order thinking is a complex and many-faceted subject. This study only briefly delves into a limited number of related issues. The Council hopes it will provide a starting point for additional study and enterprise.

The Council is indebted to Dr. Mauter for a difficult task exceptionally well addressed.

Joseph L. Davis

Dr. Joseph L. Davis
Executive Director

Mary E. Purcell

Mary E. Purcell
Chairperson

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Although this research study concentrated primarily on secondary vocational education, the report obviously has implications for postsecondary technical education, as well.

EXECUTIVE SUMMARY

This study explores some basic premises regarding the importance of higher order thinking skills to vocational-technical education. It also traces the growth of the thinking skills movement, offers some definitions of higher order thinking skills, reviews some information-processing theories, takes a closer look at problem solving, and identifies instructional considerations and issues to be addressed in teaching higher order thinking skills.

Thinking is viewed as the basic of the basics, the essential skill for success in the 21st century. The expanding needs and growing expectations of employers make it very clear that vocational-technical education must give concentrated attention to critical thinking, problem solving, and decision making. Furthermore, educational leaders need to become more fully aware of what is required in order to address higher order thinking skills appropriately in the curriculum. The author of this report found that the large majority were still in the "wait and see" stage, doing less about thinking skills instruction than the times demand.

The growth of the thinking skills movement is traced to a number of leaders in industry, economics, sociology, and education, most of whom gained prominence in the first half of this decade.

At this time, there is not a widely accepted definition, nor is there general agreement on all of the components, of higher order thinking skills. Through the examination of many definitions and lists, this study concludes that the broad term "higher order thinking skills" focuses attention upon critical thinking, creative thinking, problem solving, decision making, and reasoning.

With its historic emphasis on problem solving, vocational education has the potential to become an exemplary "teaching laboratory" for the development of higher order thinking skills. A number of essentials for achieving this potential are presented in this study.

Finally, specific activities are recommended for the Ohio Council on Vocational Education — and other individuals and entities— to consider as they pursue their leadership roles.

VOCATIONAL-TECHNICAL EDUCATORS SPEAK OUT ON "HIGHER ORDER THINKING SKILLS"

Before turning this report over to the printers, the Ohio Council on Vocational Education submitted the manuscript to a review panel of nine vocational-technical educators from throughout Ohio.

Two weeks later, the panel was invited to assemble for a roundtable discussion on the report and the subject it addresses. A highly animated 2½-hour discussion ensued. In brief, here's what the panelists told the Council:

- **It is extremely important for vocational-technical educators to teach higher order thinking skills.**

  ". . . thinking is the most basic of the basic skills."

  — Postsecondary instructor

  "I am pleased, very pleased, that this [report] is coming out."

  -- JVS English teacher

  "It is not enough to make sure that the students can perform [a] task. We hear all the time from employers who say, 'Just send me the student who can read, who can write, who can think, follow directions, make decisions, and learn.'"

  — Special Needs supervisor

  ". . . self analysis and decision making skills are important for all, but for special populations in particular.

  -- Special Needs supervisor

  "There are . . . underlying skills we can teach that can make a difference in [a student's] intelligent behavior."

  — Teacher-educator

- **Vocational-technical education has been giving attention to some aspects of higher order thinking skills.**

  "I think that vo ed has, perhaps more than any other [area of] education, the propensity to teach higher order thinking skills. I think the environment presents itself to do that . . . . The best teachers are doing many of these things already . . . . Does that mean that we're doing as good a job as we can do? No."

  — State Department official

- **Vocational-technical education has the potential for exemplary teaching of higher order thinking skills.**

  "Vocational education can [point the way for] all education. And vocational education [will] be out in front [with ideas that] other educational areas will want to consider."

  -- JVS drafting instructor

  "This is <u>really</u> the return to the basics. This is what I think we should be talking about in this country, not adding another English class or another math class or another science class and have a student who has been failing fail additional classes. We have to go back to the basics of thinking and make it worthwhile to the students."

  — Vocational director, city school district

- **Implementing the teaching of higher order thinking skills is not a simple task.**

  "This document forced me to check out six books from the library, which I should have checked out months ago. I have [found] some very informative reading."

  -- JVS drafting instructor

  "I think we ought to take [this report] back with us to our schools, take it apart, talk about it with individuals, talk about it with administrative officials, talk about it with our students. I think that there is so much here, we can't possibly cover all the implications today."

  — Postsecondary instructor

- **Teaching higher order thinking skills should be an integral part of the curriculum — not a separate course or courses.**

  "When we [consider thinking as a] process for some end result, it seems we're missing a prime opportunity if we can't build that in as a part of our ongoing curriculum. Thinking is involved in everything we do."

  — State Department official

  "It has to be part of everything you teach. And it is ongoing. It is every day. It is not just a special thing that we're going to add to the curriculum. But it is something [to] incorporate in the entire curriculum . . . ."

  — JVS drafting instructor

- **The way in which we approach teachers about teaching higher order thinking skills is very important.**

  "We have to have reasons [that teachers] can relate to and see that [what this report advocates] is different from what they have been doing before."

  — Teacher-educator

  "I think we have to break it down into segments and say, 'Here are some thinking skills that you could try. Try them. You might like them.' And then you can build on that as the teacher's imagination and interest [are] captured."

  — State Department official

- **There are specific activities that could be initiated now to heighten awareness and interest in improving the teaching of higher order thinking skills.**

  ". . . we have a very active teacher inservice education committee, and I am waiting for the opportunity to share these tenets with that inservice committee."

  -- JVS Superintendent

  "We could bring together personnel [from regional] development centers, and involve them in some dialogue about how they could optimize this kind of approach in inservice education."

  -- State Department official

  "We talk about skill events and things of this nature in our vocational student organizations, and I think [certain phases] of thinking skills could be [included in] some competitive events."

  — Association executive

  "[We possibly could have] a jointly sponsored OVA-Department of Ed initiative. Then I think we have to build it into the teacher education curriculum. There has to be some type of genesis for this to begin to germinate."

  — State Department official

PURPOSE OF THE STUDY

In retrospect, the "back to basics" movement of the '70s may have been the initial, though limited, response to concern about higher order thinking skills. While test scores did indicate a decline in basic skills, forecasts about the changing workplace of the 21st Century, the effects of global competition, the requirements of an information society, the impact of technological growth, and the increased expectations of employers made it very clear that all educators must direct their attention to more than basic skills.

These forecasts, all of which were cited in varying degrees in the critical education reform reports of the early '80s, portend the increasing need for high level cognitive skills to meet the challenges of a changing national and global society and to meet the demands of the changing workplace. As a top level business executive has said, ". . . skills that are considered 'high level' by many educators today -- including critical thinking, problem solving, and communication skills -- are likely to become 'basics' for many workers in the near future."[1]

The current focus on higher order thinking skills is one response of educators to the calls for reforms in American education related to the future needs of society and students. But it is also a result of ongoing research in the area of cognitive psychology. While some may think of "higher order thinking skills" as the latest educational buzzword, most educators understand the need for, and welcome the efforts being directed toward, improving the higher order thinking skills of students.

As might be expected, educators are in varying stages of awareness and understanding of how to improve the thinking skills of students. In analyzing the results of a survey used to prepare its 1987 report, Teaching Thinking and Reasoning Skills: Problems and Solutions, the American Association of School Administrators (AASA) estimated that 80 percent of the responding school administrators are in the "wait and see" stage, doing very little about thinking skills instruction; 15 percent are in the beginning of the "exploration" stage, reading, attending seminars, talking about it; and only 5 percent are in the "active" stage, implementing some kind of program on a pilot basis or in a limited number of buildings or grades. [2]

With approximately 80 percent of school administrators nationwide in the "wait and see" stage — and there is little reason to doubt a similar percentage among Ohio administrators and teachers — it is important to keep the attention of educators focused on the need for, and the issues involved in, teaching higher order thinking skills.

The purposes of this publication, directed primarily to vocational educators, are to review the factors that contributed to the growth of the higher order thinking skills movement, to identify salient cognitive research findings on facts that influence higher order thinking, and to identify issues that must be considered to incorporate or expand the teaching of higher order thinking skills in vocational education.

REVIEWING THE GROWTH OF THE THINKING SKILLS MOVEMENT

The impetus for today's higher order thinking skills movement stems from both inside and outside the field of education. Attention and response can be traced to a number of sources, most of which gained prominence during the first half of this decade.

Names and reports that contributed to the growth of the movement by leaders in sociology, economics, industry, and education, familiar by now to most educators, include the following:

Alvin Toffler, The Third Wave, 1980.

John Naisbett, Megatrends, 1982.

Mortimer Adler, The Paideia Proposal: An Educational Manifesto, 1982.

National Commission on Excellence in Education, A Nation At Risk: The Imperative for Educational Reform, 1983.

Ernest Boyer, High School: A Report on Secondary Education in America, 1983.

Education Commission of the States, Action for Excellence: A Comprehensive Plan to Improve Our Nation's Schools, 1983.

National Commission on Secondary Vocational Education, The Unfinished Agenda: The Role for Vocational Education in the High School, 1984.

John Goodlad, A Place Called School: Prospects for the Future, 1984.

Theodore Sizer, Horace's Compromise: The Dilemma of the American High School, 1984.

The relationship of these and other reports to the higher order thinking skills movement is rather straightforward. Coming together in a relatively short span of time, these

reports predicted the future needs of a changing society, criticized current educational practices and outcomes, and proposed needed reforms in teaching methodologies and curriculum content.

A different, but very important, perspective on the impetus for the recent attention to higher order thinking skills is presented in Vocational Education and Higher Order Thinking Skills: An Agenda for Inquiry, published in 1986 by the Minnesota Research and Development Center for Vocational Education.[3] Its authors credit "educators and educational researchers (who) have worked for many years to try to understand and solve certain educational problems that have persistently resisted solution." Among the problems that prompted and resulted in research in the area of cognitive psychology are those related to:

1. Inert knowledge -- the inability of students to connect or relate "stored" bits of knowledge to the solution of a problem.

2. Transfer of learning — the inability of students to transfer what they have learned from one situation to another.

3. Integration of knowledge -- the inability of students to interconnect discrete learned facts or principles to form a larger or whole structure to solve problems.

4. Going beyond the given -- the inability of students to go beyond what is given or to identify unspecified factors needed to interpret and solve problems.

5. Different problem types — the inability of students to recognize different problem types and their essential features, thus limiting their approaches to problem solving.

In the past, believing that little could be done to explain what goes on in the mind, behavioral psychologists approached these problems by focusing only on inputs and outputs. Cognitive theorists and psychologists, on the other hand, address these problems by focusing on mental (cognitive) processes that enhance or limit thinking and learning behavior.

The five problems noted above "relate to learners' ability to be conscious of the processes and approaches they use in taking in new information, organizing it, and bringing it to bear on their experiences . . . . One general approach that has been identified as a way of addressing these five problem areas in instruction is to help students be more conscious of their own intellectual functioning. In order to do that, educators need to understand that functioning."[4] In other words, before educators can help students to improve their higher order thinking skills to solve problems, to make decisions, to "think on their own," educators themselves must first understand the nature of cognition and thinking.

Interest and activity in the area of cognitive psychology and thinking skills have increased dramatically in the last few years. Indicators, summarized in the AASA publication,[5] include the following:

1. Increased research activity on problems related to the thinking processes, mastery, brain functioning and neurobiology, nature of intelligence, cognitive development, problem solving, creativity, reasoning, critical thinking, and how to teach and enhance students' thinking skills.

2. Increased number of scholarly books and monographs on the results of "thinking" research, more than two-thirds of which have been published since 1980.

3. Increased number of commercial curriculum programs, packages, and approaches available for teaching thinking skills, approximately 30 in 1986 and increasing at the rate of two or three every six months.

4. Increased number of related articles in education journals and periodicals, nearly 2000 in the past five years.

5. Increased attention and action from national education associations, including the large-membership American Federation of Teachers, National Education Association, and Association for Supervision and Curriculum Development organizations, resulting in heightened awareness and collaboration on the importance of higher order thinking skills, and on the publication of training programs for teachers and materials for parents. (It is interesting to note

that of the 24 national education associations that formed the Collaborative on Teaching Thinking in 1985, only the Home Economics Education Association represented the specific interests of vocational education.)

6. Increased attention by state education agencies and state legislatures, including mandates and recommendations on teaching thinking skills, problem solving, and decision making, and the development of related curriculum guides, inservice programs, publications, and measurement instruments.

7. Increased number of institutes and conferences sponsored by universities and professional associations, newsletters published by public and private agencies, and networks of individuals interested in thinking skills.

For the casual scholar, a review of the current research and literature on higher order thinking skills may be overwhelming. Trying to sort through the various theories and approaches of individual researchers is a formidable task. Fortunately, several recent documents have been published that provide rather comprehensive overviews of the current theories, research, and promising, though limited, instructional practices in the area of higher order thinking skills.

Two such publications, referenced earlier, are Teaching Thinking and Reasoning Skills: Problems and Solutions, published by the American Association of School Administrators (AASA), and Vocational Education and Higher Order Thinking Skills: An Agenda for Inquiry, published by the Minnesota Research and Development Center (MRDC) for Vocational Education.

Examples of additional attention directed toward higher order thinking skills by vocational educators include Toward Excellence in Vocational Education: Using Cognitive Psychology in Curriculum Planning [6] and Higher Order Thinking: Definition, Meaning and Instructional Approaches.[7]

An excellent overview of the technological, economic, demographic, and societal changes and trends impacting the vocational education curriculum is included in the 1986 publication, New Directions for Vocational Education at the Secondary Level.[8] The authors cite a number of deficiencies in the present mission and role of vocational education, and propose, as the title indicates, new directions on several fronts. Among

the curriculum proposals is the need to place emphasis on the development of broadly applicable and transferable skills. Of the skills listed, problem solving and decision making are most closely, if not synonymously, associated with higher order thinking skills.[9]

As also might be expected at this stage in the evolution of the thinking skills movement, there are more questions and issues to be resolved than answers. As noted in AASA survey results, there are very few higher order thinking skills programs being implemented in classrooms. While some progress is being made to teach higher order thinking skills in vocational education, most notably in the field of home economics education, the proposed research agenda presented by the Minnesota Research and Development Center provides ample evidence that much work remains. Its "Agenda for Inquiry," proposing numerous research studies, comprises fully two-thirds of the text.[10]

DEFINING AND IDENTIFYING HIGHER ORDER THINKING SKILLS

Defining or explaining what higher order thinking skills are is not an easy task. A reading of even a minimal number of publications and documents related to thinking skills allows the reader to appreciate the complexity of the issues surrounding the identification, teaching, and measurement of higher order thinking skills.

Using the descriptor "higher order thinking skills," hoping to find a tidy list of definitive skills, leads the reader to a host of other topics and issues: cognitive psychology, metacognition, learning styles, cognitive styles, information processing, problem solving, decision making, and creativity, to name a few. Proceeding with these descriptors, and limiting the search to the last 10 years, the reviewer is faced with literally dozens of articles, books, and periodicals — most published since 1980. For the most part, while less attention has been given to teaching higher order thinking skills in vocational education than in other educational content areas, limiting the search to vocational education references only, does little to reduce the volume of references related to the theoretical and research foundations of thinking skills.

Terms used to define thinking skills and processes sometimes overlap or are used interchangeably. Some writers identify a particular mental process (e.g., recalling information) as a thinking skill, others as a subskill, still others as a process step. Individual theorists may define higher order thinking skills as a few generalized skills (e.g., analysis, comparison, inference, evaluation) or, conversely, as dozens of discrete skills and subskills.

The words "higher order" create discrepancies in some definitions of thinking skills. The words imply the existence of "lower order" thinking skills. For example, all theorists and researchers agree that one must have information or knowledge to engage in "thinking." However, while some include the initial processes of taking in, storing, and recalling information in their definition of higher order thinking, others believe higher order thinking takes place when one uses information in mental processes beyond storing and recalling (e.g., combining, organizing, rearranging, synthesizing bits of knowledge into a larger concept).

Some writers point out that there are as many definitions as there are theorists, that the subject is complex, and that there are varying degrees of theoretical depth and research-based precision in defining thinking skills. Some try to "make sense" of so much information by rearranging the skills into yet another list of skills and processes, interjecting new terminology and configurations of thinking skills.

The terms "problem solving skills" and "decision making skills" are sometimes used as synonyms for higher order thinking skills. While these terms may provide the reader with a better "feel" for what higher order thinking skills are, an indepth study of the teaching and learning aspects of helping students to become problem solvers and decision makers underscores the complexity of not only defining, but teaching, higher order thinking skills.

Other writers openly admit the definitional problem and move on to related issues. There is almost humor in the AASA statement to administrators, which passes the problem on to others: "The fine points of each discussion need not hold us back here. They will be explored by your district curriculum workers and faculty members, by consultants you invite to your district, and by advocates of programs who seek to place their wares in your schools."[11]

The honesty of Ruth G. Thomas, Associate Professor and Head, Home Economics Education, University of Minnesota, regarding a definition is appreciated. She acknowledges that "the term, higher order thinking skills, is frequently used . . . as a slogan," which gets attention and gains widespread acceptance, but often leads to over-simplification and distortion. Further, "Slogans may appear more frequently in fields and around issues where knowledge is limited, and where concepts are not clear."[12] The approach often taken in response is to press on with the implementation of instructional practices and programs designed to guide or clarify the meaning of the "slogan" — in this case, higher order thinking skills.

Acknowledging the definitional variations and limitations found in the literature, the following two general, but representative definitions of thinking and higher order thinking, respectively, establish a context for a more indepth study of higher order thinking skills:

> ". . . . mechanisms by which people take in, process, store, combine, retrieve, and use information in directing, performing, and controlling operations; understanding and affecting situations; interpreting experience; identifying and solving problems; and making decisions and judgments."[13]

". . . . purposeful, extended lines of thought (used by people to) 1) Identify a task or problem type; 2) Define and clarify essential elements and terms; 3) Judge and connect relevant information; 4) Evaluate the adequacy of information and procedures for drawing conclusions and/or solving problems. In addition, students engage in metacognition. This involves becoming critical of the strategies they use, becoming self-conscious about their thinking, and developing self-monitoring, problem solving strategies."[14]

Lists of specific mental skills or processes involved in higher order thinking vary in terminology, but follow a fairly standard progressive pattern. Each of the following numbered lists is representative of the skills, in ascending order of scope and sequence, identified by various researchers:

1. Recall - analysis - comparison - inference - evaluation.

2. Concept formation - comprehension - argumentation.

3. Setting a purpose - gathering, organizing, analyzing, synthesizing and integrating information - applying solutions.

4. Defining and clarifying a problem - judging information - solving problems/ drawing conclusions.

5. Application - analysis - synthesis - evaluation.

6. Analyzing - comparing - inferring and interpreting - evaluating.

7. Information processing - analyzing - classifying - comparing - formulating hypotheses - drawing conclusions - criticizing.

8. Translation - interpretation - extrapolation.

Commonalities among the above are obvious. Selecting a particular theory or configuration of skills as the foundation of a school-based program to improve students' higher order thinking skills should be based on a thorough review and acceptance of any given theory and its supportive data.

The use of increasingly complex thinking skills along the continuum, to solve problems for example, is one reason for the emergence of the term "higher order thinking skills." This designation, unfortunately, implies the existence of a specific point along the continuum separating skills into higher and lower order thinking skills. However, since all skills on the thinking-process continuum, including the process of taking in information, are important for problem solving and other high level functions, it could be said that all thinking or mental skills are higher order thinking skills, deserving instructional attention.

In essence, the broad term "higher order thinking skills" focuses attention on the need for students to use increasingly complex thinking skills to attain the highest levels of instructional outcomes. Included are the following:

Critical thinking — solving problems and making decisions.

Creative thinking — creating original or modifying former products or ideas.

Problem solving — reaching a specific goal to resolve an identified problem.

Decision making — making a decision from among competing alternatives.

Reasoning - making a judgment based on facts, values, and attitudes.

Some theorists and educational researchers view the above as separate skills, directing their attention to specific definitions and instructional approaches. Others, seeing each as beginning with a "problem" and ending with a "solution," consider them all problem solving skills. Nevertheless, the list identifies oft-cited, complex educational outcomes and helps to clarify what is meant by higher order thinking.

Eventually, the goal of teaching higher order thinking skills is to have students be conscious of, become actively involved in, and take responsibility for, their own thinking and learning. This state of consciousness and involvement in thinking is called metacognition. According to the AASA definition, metacognition, neither a thinking process nor a thinking skill, is an attitude, a point of view, a way of being aware that a person is thinking; it refers to individuals' awareness of their own cognitive performance and the use of that awareness in altering their thinking behavior.[15]

As noted earlier, all researchers acknowledge the need for information for thinking, but many do not include "taking in information" in their delineation of higher order thinking skills. For example, Laster defines higher order thinking as "purposefully processing information beyond specifically memorizing or recalling information."[16] The discrepancy may be important to theorists or researchers, but educators cannot overlook their responsibility of helping students to both take in and use information. Therefore, any school-based program focusing on higher order thinking skills must incorporate components that deal with how students acquire and process knowledge. Certainly, trying to improve the higher order thinking skills, problem-solving, and decision-making skills of students is more difficult if knowledge is missing or faulty, and if educators lack an understanding of information-processing theories and the progressive nature of thinking processes.

While different terms may be used to describe a particular cognitive function, each skill is an important part of the thinking process, and each must be sufficiently developed if students are to do well in and out of school. The following chapter reviews some of the many personal and instructional factors that influence how students process information, and which certainly affect the development of higher order thinking skills.

REVIEWING INFORMATION-PROCESSING THEORIES

Information-processing theories focus on how people "collect, store, modify and interpret information from their environment, retrieve and restructure already stored information, and how people use their knowledge and information in every facet of human activity."[17]

Research on factors that influence how students take in and process information has altered the instructional strategies of teachers as they become aware of individual learning style variations along the entire continuum of thinking skills. The term "individual differences" takes on new meaning, and becomes particularly relevant, as instruction focuses on higher order thinking skills.

All productive thinking requires information or knowledge, and one has only to think of his or her own information-processing or learning style to understand that "people see and make sense of the world in different ways. They give their attention to different aspects of the environment; they approach problems with different methods for solution; they construct relationships in distinctive patterns; they process information in different but personally consistent ways."[18] Identifying and accommodating individual differences in students' information-processing styles is a formidable responsibility for educators, but critical if students are to achieve their highest possible achievement levels.

Much of the research on information-processing and learning styles complements other research being done in areas related to higher order thinking skills: intelligence, competence, comprehension, and creativity. For example, "Recent concepts of intelligence have increasingly expanded beyond the idea that intelligence is 'bestowed,' stable and static, to the idea that intelligence has multiple dimensions that are learnable to at least some extent through experience and education."[19] Also, research in the area of competence "has revealed the significance of motivation, values, perceptions, priorities, and expectations in contrast to abilities alone as essential in competence."[20]

What has evolved is a body of knowledge on information-processing and the identification of factors that influence how students take in and process information. An indepth review of the research is beyond the scope of this publication. However, the following factors summarize important aspects of various information-processing theories. More

information can be found in Learning Styles: Applications in Vocational Education[21] and Vocational Education and Higher Order Thinking Skills: An Agenda for Inquiry.[22]

1. Context in which something is learned -- Associating new information with previously encoded knowledge, stored according to internally constructed codes, is influenced by the context in which new information is received or experienced, which affects subsequent recall and transfer of knowledge to other situations. Context also involves the effect of visual, auditory, tactile, and kinesthetic senses to facilitate encoding, storing, and recalling information, as well as the effect of different presentation modes, such as words, pictures, symbols, numbers, and manipulative or hands-on experiences.

2. Different memory systems -- Opposing the theory of a single memory (storage) system, some researchers suggest that humans have separate memory systems, among them, verbal, visual, motor, episodic, and semantic. Encoding and storing knowledge in one memory system may affect recall and transfer of learning if other types of cues come into play.

3. Understanding relationships between knowing and doing -- Improving students' higher order thinking skills calls for providing instructional strategies that show students how to move along the thinking or learning continuum, that is, from the acquisition of bits of information (declarative knowledge - what one "knows") toward the transformation of information into effective performance (procedural knowledge - what one "does").

4. Knowledge structuring and structures — Integrating or structuring information into larger systems of knowledge is influenced by what is already known (stored, coded) and by affective and cognitive factors. As the number of linkages or associations among bits of knowledge increases, larger systems called schemas or scripts emerge, allowing one to quickly assimilate and use new information in either a general or precise manner. The more complex the pattern or network of integrated knowledge, the easier and faster it is for one to apply knowledge to new situations (e.g., to solve problems). The structuring process can be affected, for example, by one's experiential- and cultural-based perceptions of information as being important/unimportant, applicable/inapplicable, familiar/unfamiliar, appropriate/inappropriate, etc.

5. Processing styles — Processing information appears to be a matter of individual style, preference, or approach to learning. Taking in, storing, recalling, integrating, and using information may be approached in a single way or a combination of ways that have been identified as methodical, random, sequential, concrete, abstract, practical, theoretical, logical, conceptual, hypothetical, imaginative, creative, part/whole, and whole/part, among others.

Other, and perhaps more familiar, conditions that influence learning and affect the above factors are:

6. Environmental conditions -- Light, temperature, climate/weather, sound, noise, time of day, day of week, etc.

7. Physical/emotional conditions — Hunger, rest, energy level, sight, hearing, emotions, motivation, confidence, expectations, time constraints, rigidity, flexibility, interests, etc.

8. Relationships/interactions -- Competition, cooperation, source and importance of support, encouragement and reinforcement, working alone, with a partner, or as a team member, etc.

Given the relationship and importance of information—processing factors in the development of higher order thinking skills, the instructional implications are obvious. Not only must educators understand the general nature of the cognitive processes involved in higher order thinking, they must also consider the conditions and factors that influence these processes among individual students.

TAKING A CLOSER LOOK AT PROBLEM SOLVING

The current emphasis on improving students' higher order thinking skills has increased attention on specific aspects of problem solving. As noted earlier, much of the focus in teaching thinking skills is on problem solving in the broadest sense. Several dimensions affect the development of problem solving skills: types of problems, problem solving methods, and problem solvers themselves.

1. Types of problems — Problems are categorized by various researchers as well-defined/ill-defined, well-structured/ill-structured, or formal/informal problems. Most problems presented to students in an instructional context are of the well-structured (well-defined, formal) type. Well-structured problems have a "right" answer or a proof to test the student's conclusion or solution. They are presented or occur in such a way that the student has a clear understanding of the given situation or condition, all relevant information or components affecting the situation or condition, knowledge of the goal or solution intended, standards or tests for verifying solutions, and knowledge of applicable operations, procedures, tools, and resources needed to solve the problem.

   Ill-structured or ill-defined problems (not to be confused with poorly presented, well-structured problems) are those often encountered in everyday personal, social, and work contexts. There may be more than one proposed solution, for which no one "right" answer or proof is available to test the student's solution. Ill-structured problems are those that are presented or occur in such a way that the situation or condition is vague, fuzzy or not fully understood, relevant information or components are missing or vague, goals or criteria for verifying the solution are vague or unknown, and there is little or no initial understanding of applicable procedures, operations, tools, or resources needed to address or solve the problem.

2. Problem solving methods — Being able to solve problems requires both knowledge, or access to information, and cognitive processing skills. Assuming one possesses or has access to applicable knowledge, the problem solving

process, whether for well-structured or ill-structured problems, consists of the following four general steps or stages:

a. Defining or "representing" the problem in such a way that the conditions and/or situation, as well as the desired goal or proposed focus of a solution, are clearly understood.

b. Breaking down, reducing, or "constructing" the problem into relevant elements or factors for consideration, and determining what information is known or needed for an indepth study of each element.

c. Selecting one or more methods or approaches for solving the problem. These may include proposing a solution known to be effective or applicable in similar situations; using the "trial and error" method, in which many solutions are proposed and tested; identifying and solving subgoals or components of the problem, which, in combination, achieve the final goal; or proposing approaches perceived to be practical, logical, or reasonable.

d. Applying the selected problem solving approach or methods and testing or assessing the results to determine if the problem has been solved; that is, if the desired goal has been reached.

While the terminology and number of steps in the problem solving process may vary from author to author, the sequence remains generally the same. The issue from an instructional point of view is ensuring that students possess or have access to relevant information, and that they understand and can apply a variety of appropriate procedures for solving problems.

3. Problem solvers — Much of the information previously provided about how students take in and process information is applicable in understanding differences among students as problem solvers. Certainly the amount and breadth of knowledge, the ease and rapidity of making associations among and between diverse cues, the ability to transfer knowledge from one situation to another, and the individual approach may influence and account for varying levels of competency in problem solving and other higher order thinking.

Another dimension is the element of practice. Wassermann's[23] recent, timely update of Louis E. Raths' earlier theory of thinking (Teaching for Thinking: Theory and Application, 1966) points to the importance of providing opportunities and experiences for students to practice using higher order thinking skills. According to the theory, students who lack experience in developing thinking skills exhibit behaviors that indicate deficits in thinking. Barring physical or psychological causes, students with underdeveloped thinking skills may be:

1. Impulsive thinkers and doers.
2. Overdependent on the teacher or others for help.
3. Unable to connect means with ends.
4. Unable to grasp the meaning of something or to conceptualize big ideas or large issues.
5. Closed-minded and dogmatic about their beliefs.
6. Rigid and inflexible, resistant to new ideas.
7. Underconfident about their ideas.
8. Anti-intellectual, resistant to thinking if standards of accomplishment are in doubt.

These behaviors inhibit problem solving and other higher order thinking, separating effective, expert problem solvers from ineffective, novice problem solvers. Thus, in addition to providing information and knowledge to students, educators must teach students how to think. Students must also be provided many experiences to practice their higher order thinking skills in order to solve both well-structured and ill-defined problems and to deal with other situations they will encounter in life.

IDENTIFYING INSTRUCTIONAL CONSIDERATIONS

A number of educational and societal factors that may account for the present lack of active commitment to teaching higher order thinking skills have been identified by Wassermann[24] as follows:

1. Classroom materials and practices that work against the promotion of thinking.

2. Inadequate teacher training programs.

3. Inservice workshops and other professional development experiences that do not provide long-term study and in-classroom support for learning process skills.

4. Unsympathetic administrators who are unsupportive of teaching strategies that would cultivate pupils as thinkers.

5. Teacher "rewards" to students who sit quietly, don't ask uncomfortable questions, give the "right" answers, and do as they are told.

In addition to these factors, the following have specific relevancy to vocational education:[25]

1. The traditional job-specific training orientation of vocational education.

2. Federal and state funding and legislation that fostered the separation from, and hindered the coordination and articulation with, "academic" education.

3. Teachers who are hired for their technical expertise in a specific occupational area, rather than for their academic teaching expertise.

Not to be discounted as a reason for the lack of progress in teaching higher order thinking skills is the fact that teaching and measuring complex thinking skills are hard

work and time consuming, requiring an indepth understanding of thinking processes and the use of multiple strategies to accommodate the individual learning and thinking styles of students.

These and many other issues must be addressed as educators move from the wait and see stage, through the exploration stage, and into the active stage of teaching higher order thinking skills. The implications of the following issues should be carefully reviewed by local administrators, teachers, and parents.

1. Attitude and Commitment of Educators and Parents — Selecting or designing instructional strategies to teach higher order thinking skills requires careful thought and preparation. Educators and parents must be committed to the importance of improving students' thinking skills and have an indepth awareness of the many factors involved. They must also appreciate the value of the thought process, in addition to the quality of "correctness" of a response, solution, or behavior. For example, Sternberg points out, ". . . very often in critical-thinking problems, there are no right answers. And even when there are, it is the thought process that counts."[26]

2. Goals and Outcomes — It is important to clarify the goals and desired outcomes of a thinking skills program. As noted earlier, problem solving, decision making, critical thinking, creative thinking, and reasoning have similar, but different, instructional outcomes. Teaching strategies and practice exercises must be closely linked to the outcomes.

3. Implementation Models — Decisions need to be made about whether higher order thinking skills will be taught as a separate course, as part of the content of every course, or in selected program areas. While separate instruction ensures that indepth attention will be focused on the specific components of thinking skill processes, infused instruction facilitates the linkage of thinking skills to the curriculum content. Perhaps a combination of both approaches should be considered. The advantages and disadvantages provided in the Summary of Integrated and Nonintegrated Models for the implementation of basic skills programs in vocational education can be used as a guide.[27] Included are considerations related to the students, participation of staff in instruction, space allocations and environment, curriculum implications, and costs.

4. Evaluation — Measuring the quality or level of a student's application of higher order thinking skills to solve problems, make decisions, reason, and think critically and creatively calls for new evaluation approaches, particularly if it is "the thought that counts." A number of studies have shown that the use of essays, teacher observation, practical applications (e.g., solving a specific problem), and simulations may be effective in evaluating students' thinking skills.[28] In addition, there must be provisions for evaluating the overall effectiveness and implementation of the school program.

5. Locally Developed vs. Commercial Programs — Arguments regarding the choice between developing a local program and purchasing a commercially-available program can be applied to the decision on thinking skills programs. Among the issues are compatibility with local goals, expertise of local personnel, costs and timeliness, ownership, and provisions for inservice.

6. Inservice — Certainly there must be a commitment to providing effective and long-term inservice for teachers to ensure success and results of any program. Little can be accomplished in a few one-hour workshops to move educators beyond the awareness level. Time, materials, training by experts, reinforcement, and feedback must be available in large measures.

SUMMARY: IMPLICATIONS FOR VOCATIONAL-TECHNICAL EDUCATION

Vocational education leaders responded quickly to the national call for educational reform. While most of the reports critical of American education ignored vocational education, vocational educators set about taking a hard look at their own programs. Acknowledging weaknesses and the need for changes in the role, mission, and vocational education curriculum, they have renewed their commitment to vocational education as both a "body of knowledge and an educational process," with the capacity to promote, among other outcomes, "problem solving, analytical skills, use of scientific inquiry, and reasoning."[29]

Thinking is viewed as the basic of the basics, the essential skill for success in the 21st Century.[30] Given the large segment of the nation's student and adult population appropriately served by vocational-technical education, it is imperative that these students possess the necessary reasoning, problem solving, decision making, creative, and critical thinking skills, in addition to occupational skills, to get and keep or change jobs, and most certainly for adjusting to and meeting the demands and challenges of the future, so aptly described in the reports cited earlier.

While most research has been focused on the teaching of thinking skills in traditional academic courses, there is evidence of increased attention to the importance and applicability of teaching higher order thinking skills in and across vocational education service areas. A few examples follow.

Greenan[31] identified reasoning skills as necessary for success in vocational training programs, and found the majority of the 40 subskills were important and highly generalizable (basic and transferable) within and across vocational agriculture, business, health, home economics, and industrial occupations programs. He recommends that school personnel "begin or continue to use generalizable skills in instructional planning, curriculum development, instructional methods and delivery, and monitoring and evaluation . . . . Teachers should examine their curricula and infuse assessment, teaching, monitoring, and evaluation activities to develop students' generalizable skills."

Champagne[32] discusses how vocational education can facilitate the teaching of thinking skills for success in the workplace, providing several problem-solving examples.

Kister and Laster[33] and Laster, Matthews and Manifold[34] have focused on the need for practical reasoning skills to solve practical problems in home economics, identifying specific dimensions of practical reasoning (knowledge, proficiencies, and attitudes), instructional strategies, and evaluation instruments for assessing practical reasoning skills in home economics.

Laster[35] has done extensive research in the area of information-processing and cognitive psychology theories, and suggests curriculum models in which vocational educators can infuse problem solving, self-monitoring, and learning skills instruction into the curriculum.

Henderson[36] focuses on practices and strategies to develop critical thinking skills that can be implemented by vocational agriculture instructors and teacher educators.

Findings from the pilot test projects of Program Options, curriculum approaches developed by the Ohio Department of Education to strengthen the academic components of vocational education, may have implications for teaching students higher order thinking skills.[37]

In addition, it has been suggested that elements of the present vocational education curriculum may promote the development of higher order thinking skills. Such instructional strategies as applied academics and use of problem solving methods may be good starting places for formalizing programs to improve students' higher order thinking skills.

The sense one has regarding vocational education's formal involvement in teaching higher order thinking skills is that "not much is going on." If this perception is wrong, then the progress is not adequately reflected in the literature, nor is it well-known and documented by others in the field. While a survey of districts and schools was not conducted for purposes of this document, the few efforts that were identified appeared to be less than formalized, hit-and-miss, or of varying degrees of depth and breadth within and across vocational service areas. It would probably be safe to say that the majority of vocational administrators, instructors, and teacher educators are at the "wait and see" stage.

Vocational education cannot afford to wait too long. Never has the need for teaching higher order thinking skills been more imperative or well-articulated than it is today. Moreover, given the stirrings of attention, research, and curriculum development by a number of vocational educators and researchers, the time is right for building a coalition

of those who possess the knowledge, commitment, and willingness to move forward in this arena — researching, designing, implementing, and evaluating programs to improve the thinking skills of students.

Vocational education has the potential for becoming an exemplary "teaching and learning laboratory" for the development of higher order thinking skills. Reaching this potential will depend on a number of things, including:

1. State and local leadership, commitment, and support to establish the priority nature of the effort.

2. An increased awareness at all levels about what higher order thinking skills are and why it is important that all students develop these skills.

3. A belief that teaching higher order thinking skills should and can be part of the vocational education curriculum.

4. A willingness and commitment to spend the time and effort needed to help students develop their higher order thinking skills.

5. The availability of quality instructional materials, proven teaching practices, and practical evaluation strategies.

6. Adequate inservice and assistance.

7. Ongoing research in cognitive functioning, instructional strategies, and evaluation.

8. Meaningful articulation and collaboration among and between practitioners, researchers, teacher educators, and curriculum developers.

RECOMMENDATIONS

The recommendations presented below were made by the researcher as a result of the findings and insights obtained in the course of the study. Originally, the recommendations were addressed to the Ohio Council on Vocational Education in the belief that the Council might wish to act on the recommendations in pursuing its leadership role.

The Council is of the opinion that these recommendations merit the consideration of all others — be they individuals, organizations, or governmental agencies — who bear responsibility for strengthening vocational education in Ohio.

The recommendations are as follows:

1. Promote articulation and commitment among vocational educators and administrators at all levels and in all program areas on the importance of ensuring that vocational education students develop the necessary higher order thinking skills to live and work successfully throughout their lives.

2. Appoint and charge a statewide committee of vocational educators, teacher educators, researchers, and administrators, knowledgeable and active in the thinking skills movement, to:

   - Provide direction and leadership for coordinating and expanding state and local involvement in programs designed to improve the higher order thinking skills of vocational education students.

   - Develop a collaborative position paper clarifying what higher order thinking skills are, the need and importance of these skills to students, and the responsibility vocational educators have for teaching higher order thinking skills within and across all program areas.

   - Identify and assess the types and status of thinking skills programs currently being implemented in Ohio vocational programs by means of a survey or other search, and share the findings with appropriate others.

   - Formulate and execute systematic plans for coordinating current efforts, establishing broad program goals, determining long-range needs, and developing strategies for meeting those needs, including the involvement of others and the development of curriculum objectives and materials, training programs, and evaluation strategies.

3. Hasten efforts to increase the awareness and involvement levels of all vocational educators by disseminating information, conducting seminars, and sponsoring statewide conferences on higher order thinking skills.

4. Select or establish pilot teaching programs for the purpose of increasing the body of knowledge and resources on various aspects of teaching and learning higher order thinking skills in vocational education.

5. Promote the efforts and contributions vocational educators and researchers are making in higher order thinking skills research, curriculum development, instruction, and evaluation to the wider education community.

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